APPLICATION OF THE SIMNET UNIT PERFORMANCE ASSESSMENT SYSTEM TO AFTER ACTION REVIEWS

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Simulation Networking (SIMNET) provides a means to supplement collective field training, but research is needed to develop a SIMNET training strategy. The U.S. Army Research Institute (ARI) and Perceptronics developed a prototype PC-based Unit Performance Assessment System (UPAS) to collect time-tagged data on firing events and vehicle status from the SIMNET network and display data summaries. The UPAS is intended to assist in preparing unit performance summaries necessary to provide units with feedback during After Action Reviews (AARs) and conduct training research. This paper describes a project by ARI and the Institute for Simulation and Training (IST) involving the design and software implementation of procedures for combining network data with non-network data within the UPAS to support the preparation of improved AAR aids. These aids may be applied to future generations of networked simulators such as the Close Combat Tactical Trainer (CCTT).

INTRODUCTION

The networking of combat vehicle simulators makes it possible for crews to interact with one another on a common terrain database. Information produced by each simulator, such as its location on the terrain database and the target location of each firing engagement, is broadcast over the network and picked up by other simulators.

The initial simulation networking device (SIMNET) developed by the Defense Advanced Research Projects Agency included simulators for armor and mechanized infantry vehicles.[12] SIMNET, like all applications of Distributed Interactive Simulation (DIS), is intended to train crews to work together as part of a unit and train units to work together as part of a larger organization, but it is not intended to support individual skills training per se. SIMNET, for example, lacks the fidelity required to use it to train individual gunnery skills[4], but it can be used to train a unit how to use a volume of fire to cover the movement of another friendly unit.[2]

In 1988, Thorpe reported evidence that SIMNET training transfers to field training exercises.[12] In the interim, two efforts employing Armor Officer Basic students as subjects have provided additional evidence of training transfer [1,10], and three analytical efforts have identified collective tasks that might be trained in SIMNET.[2,4,6] Much of this training transfer work was accomplished in order to decide whether the relatively low level of fidelity of certain aspects of SIMNET prevent transfer to field training.

Three recent reports stressed the importance of assessing the effects of SIMNET feedback and practice variables on transfer of training.[1,6,10] Two of these reports provided evidence that the transfer of SIMNET training increases as trainers gain experience in the conduct of SIMNET training.[1,10] These two reports also suggest that the improved performance as trainers gain experience with SIMNET is a function of the quality of feedback given to exercise participants during After Action Reviews (AARs).

The AAR is not a critique of unit performance with respect to a predetermined list of standards. Instead, it focuses on events that contributed significantly to mission outcome and the causes of these events.[8,9] The AAR is intended to be an interactive learning process in which participants discuss what they did, why they did it, and possible alternative courses of action. The job of guiding discussions of events is made easier to the extent that information about these events is available in the form of graphs, tables, and figures.

In general there is a dearth of information regarding the AAR and practice variables that influence SIMNET training. Data on these variables are needed to develop efficient strategies for integrating SIMNET training into a total collective training strategy that includes field training exercises at home station and training at the Army's National Training Center (NTC).

The lack of information on SIMNET training is understandable when one considers the complexity of collective training combined with the lack of SIMNET data analysis tools. A collective exercise is generally composed of multiple interdependent collective tasks. How a unit performs one of these tasks influences; the conditions under which subsequent tasks are performed, whether or not certain tasks or subtasks must be performed, and how subtasks should be performed. This variability in unit performance requirements makes it necessary for trainers and researchers to perform substantial analyses to provide effective feedback and document the training that is conducted. It should not be too surprising that the various training transfer efforts have documented the training conducted only at a very broad level.

SIMNET includes powerful tools for observing unit performance during and after an exercise. These tools include a "Stealth Vehicle" that allows a trainer or researcher to obtain an "out the window view" of the action from any point on the battlefield and a Plan View Display that allows the action be observed from a bird's-eye view.[12] However, translating this wealth of available information to a format that supports documentation of training (practice and feedback) and measurement of unit performance is expected to be a substantial task.

THE PROTOTYPE UNIT PERFORMANCE ASSESSMENT SYSTEM (UPAS)

ARI and Perceptronics developed a low cost, personal computer-based (PC-based) Unit Performance Assessment System (UPAS) to assist in collecting and analyzing data from SIMNET exercises. UPAS collects virtually all of the data broadcast over the network for subsequent analysis on a stand alone basis. The prototype UPAS contains two types of tools to support training feedback and research.[14] First, UPAS loads data from the network into a relational database, and provides a menu-based system of editors for creating graphic and tabular summaries of unit performance from these data. The design of the database is based on the NTC database to support research on collective training strategies. Second, the prototype contains a Plan View Display (PVD) that can be used to replay the mission or critical segments of the mission from a bird's-eye view. In addition to showing vehicle location and weapon system orientation over a grid map, the PVD indicates when each vehicle fires or becomes a casualty. This prototype UPAS includes the capability to magnify the battlefield to the point where the entire display covers an area that is only one kilometer square. Figure 1 illustrates a PVD screen, and Figure 2 shows a graph developed with the UPAS.

In the next phase of development, ARI and the University of Central Florida Institute for Simulation and Training (IST) expanded and modified the UPAS to support training feedback and research more effectively, addressing two major concerns. First, it was necessary to begin integrating the data collected from the network by UPAS with data from non-network sources (e.g., unit plans for conducting the mission) to provide a more complete description of unit performance[5,6]. Second, it was necessary to provide data summaries that could be used to assess unit performance quickly after an exercise. Unlike a field training exercise, there are few post-mission tasks after a SIMNET exercise to keep a unit occupied while a trainer analyzes unit performance in preparation for providing feedback. It is critical that UPAS support the preparation of timely AARs. Figures were considered to be a good vehicle for integrating network data with non-network data and providing quick summaries of unit performance.

APPROACH

ARI developed concepts for Plan View Display modifications and new types of AAR aids to integrate network and non-network data while providing easily interpretable descriptions of unit performance. These concepts were further specified by examining a sample of unit performance measures that might be addressed using these aids to identify the information each type of aid would need to contain. The sample measures were Armor Platoon Mission Training Plan standards[3] classified as being supported by SIMNET[2] that might employ the network data collected by UPAS.

The second step was to develop the software necessary to implement the concepts of new or improved AAR aids. One challenge that faced IST was to implement these concepts in a manner that supports rapid display of each aid after an exercise. A second challenge was to implement these aids in a manner that allows them to be used or modified in a flexible manner.

The third step was to categorize representative measures of unit performance according to similarities in network and non-network data requirements necessary to support their application. The fourth step was to assign categories of performance measures to AAR aid formats based upon each format's ability to accommodate data types. This step was necessary to facilitate systematic application of AAR aids to performance measurement.

The results are described below in terms of; the AAR aids implemented, the software techniques employed, and the categories of performance measures appropriate to each aid.

NEW UPAS AAR AIDS

The PVD was modified to support training feedback and research more effectively, and three new types of AAR aids were implemented. Two of the new aids, the Battle Flow Chart and Battle Snapshot, provide a bird's-eye view of the battlefield conveying information that is not easily addressed by the PVD format. The third aid is in the form of a timeline.

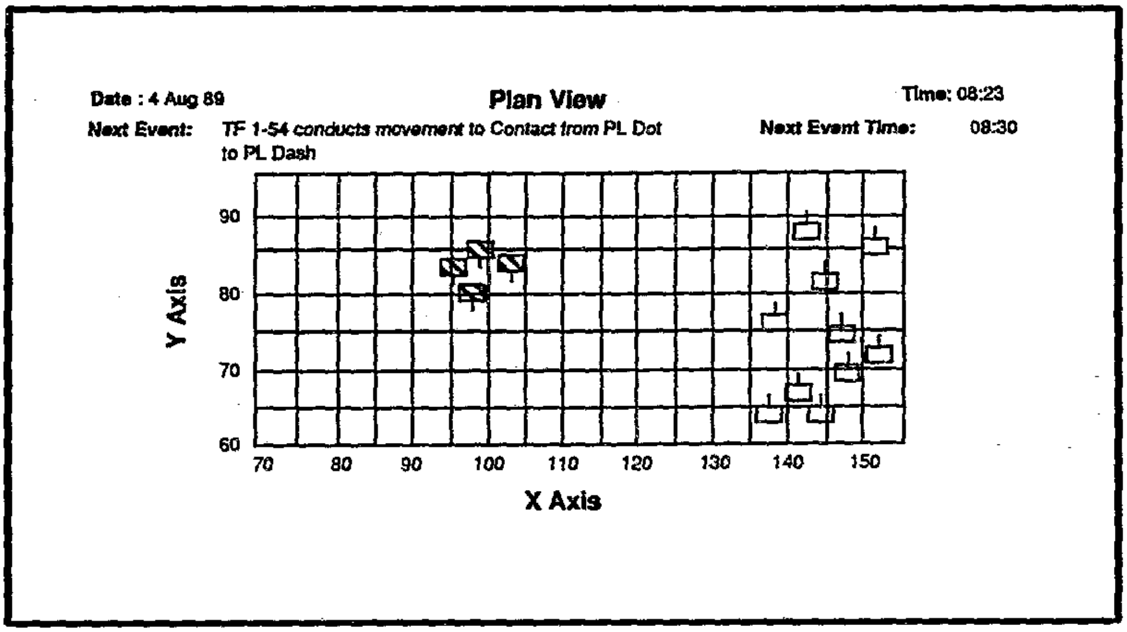

Figure 1. Example of a UPAS Plan View Display (PVD) Screen

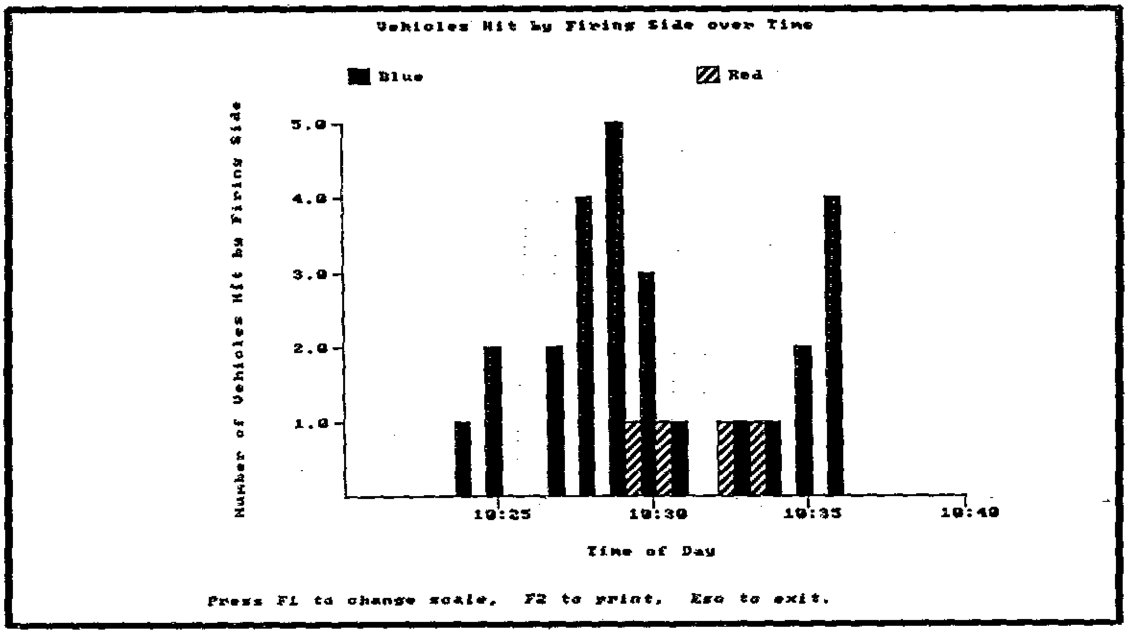

Figure 2. Example of a graph prepared by the UPAS showing volume of fire as a function of time and unit side.

The capability to display major terrain features (i.e., highways, unimproved roads, tree lines, tree canopies, buildings, and bodies of water) was added to the Plan View Display as shown in Figure 3. These features are all color coded in the display. In addition, a quick search capability was implemented to allow the user to move quickly forward and backward to particular points in an exercise, and the capability to magnify the battlefield was enhanced to allow sections as small as 200 meters squared to be displayed.

The Battle Snapshot shows the position and orientation of vehicles and weapon systems from a bird'seye view (See Figure 5). A Snapshot can be taken of any point in the exercise designated by the user. Like the PVD and Battle Flow, the Snapshot employs a grid map that includes terrain features and control measures.

....An Exercise Timeline is a tool for looking at temporal coordination of movement, firing events, control measures, and communication. An example of a timeline is provided in Figure 6. The top and bottom lines cover the time during the

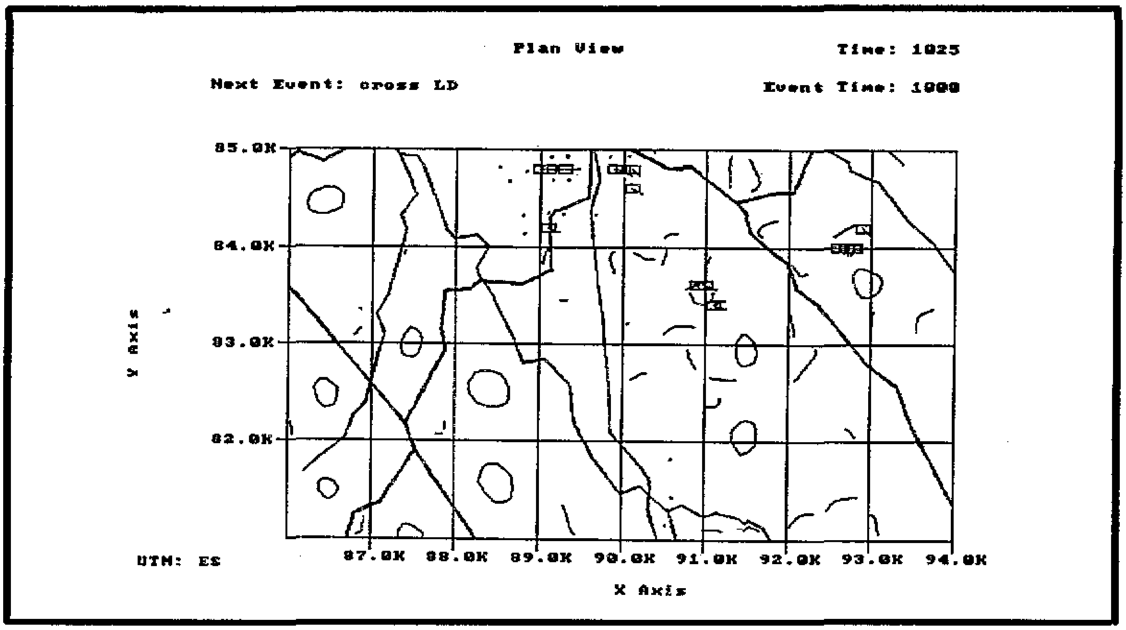

Figure 3. Improved UPAS Plan View Display

A Battle Flow Chart was implemented to trace the movement of vehicles from a bird's-eye view at specified intervals throughout the course of a mission (see Figure 4). The Battle Flow traces movement over a grid map displaying terrain features and unit control measures. The user can start movement at any point in the exercise, and thus a hard copy of the trace can be made for selected portions of the exercise as well as for the entire exercise. The Battle Flow indicates vehicle location but does not indicate vehicular and weapon system orientation. The Battle Flow, like the Plan View, allows the user to magnify the battlefield.

exercise. The second line describes movement of the platoon as a function of time and unit control measures by using bars to indicate the time when the first and last vehicle of a unit crossed a control measure. The Timeline also indicates the beginning and ending of periods of time when the entire platoon was halted. The third line provides information about the time of direct and indirect firing events. A small square is used to indicate a point in time when the unit receives artillery fire, and a down arrow indicates when the first enemy direct fire was received by the unit. A circle indicates when a friendly vehicle is destroyed. An up arrow indicates when the unit first delivers fire on the enemy, and "x" indicates when an enemy vehicle is destroyed.

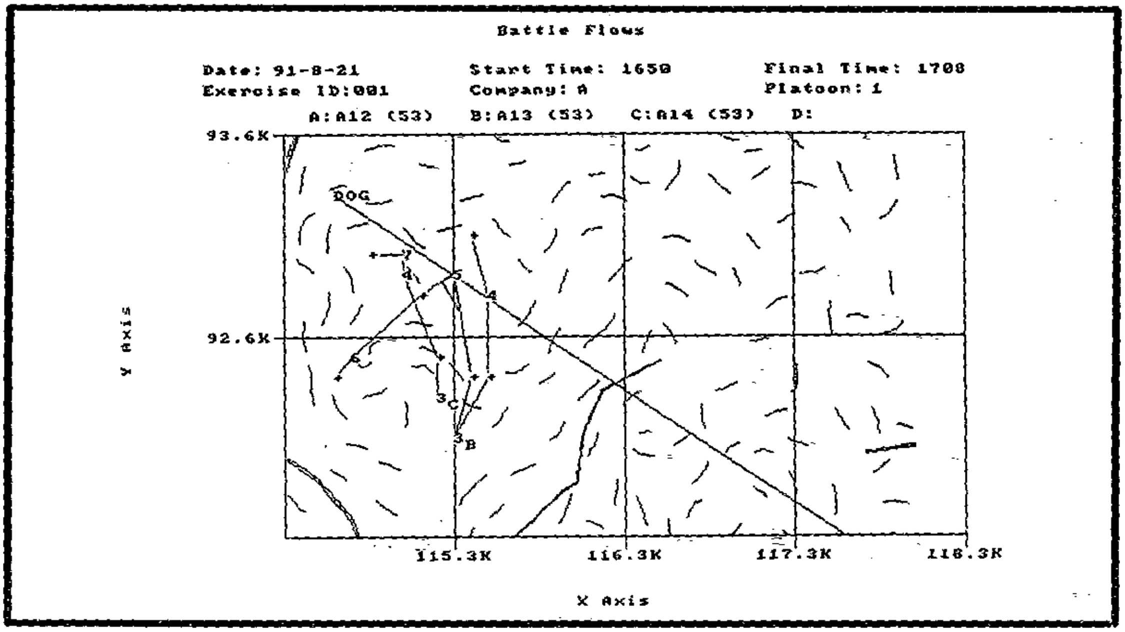

Figure 4. Sample Battle Flow Chart.

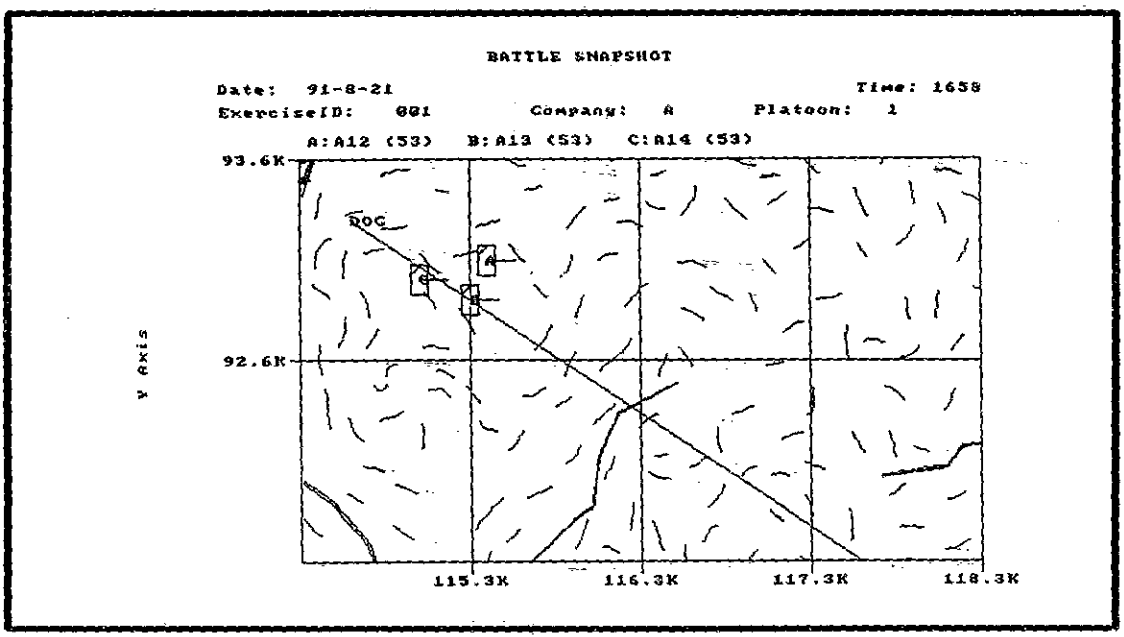

Figure 5. Sample Battle Snapshot.

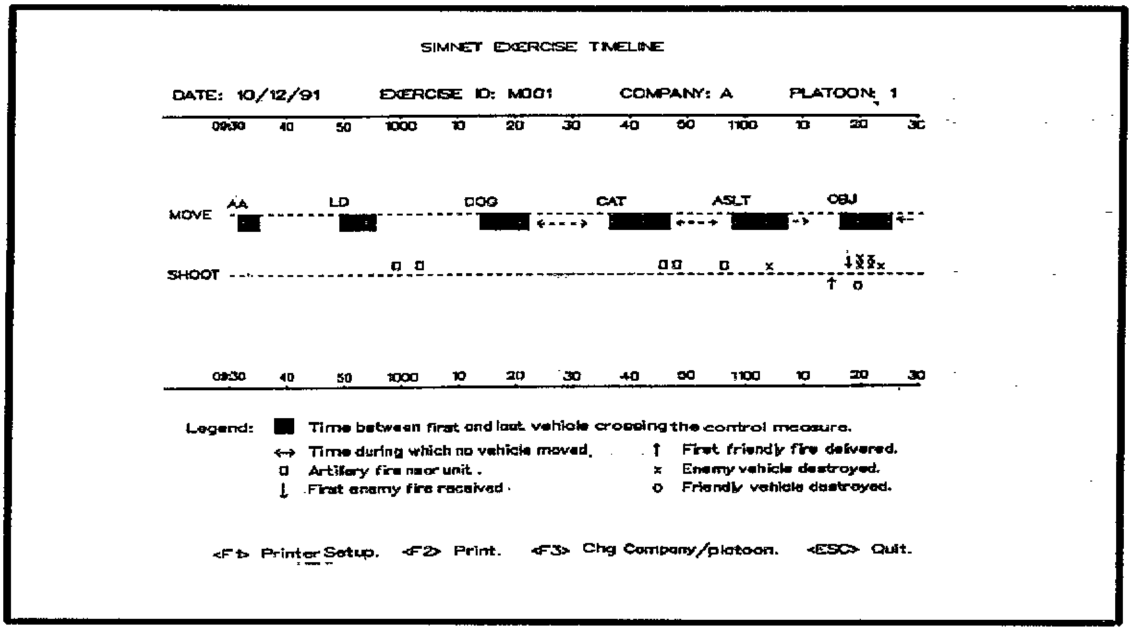

Figure 6. Sample SIMNET Exercise Timeline.

PROGRAMMING METHODS USED TO IMPLEMENT AAR AIDS

Integration of Non-Network Data Sources

Unit control measures, terrain data, and tactical communications are three of the major sources of non-network data to be integrated with network data to support performance assessment. How well movement, firing events, and communications comply with control measures is an important measure of unit proficiency. The manner in which a unit adjusts its actions to reflect the terrain situation is also an important measure of unit proficiency. Further, terrain is important because the unit's vision, movement, and firing activities are, to a large extent, constrained by the surrounding terrain features. Finally, tactical communication data are critical because SIMNET's greatest strength is estimated to reside in the ability to support the training of command, control and communication activities within units.

A utility was developed to allow the user to input information about the name, type, and location of control measures into the relational database. UPAS currently supports any two dimensional control measure that can be represented by a point, line, or circle. These control measures are displayed in the PVD, Battle Snapshot, and Battle Flow chart, and they are used by the Exercise Timeline to compute when a platoon crosses each control measure. Future work in this area involves integrating three dimensional control measures, such as Airspace Coordination Areas.

UPAS has successfully incorporated terrain features into the PVD that include: tree lines, tree canopies, dirt roads, paved roads, rivers, and buildings. All information is obtained from the SIMNET terrain database that includes a database header and a list of terrain patches. A copy of the terrain database is loaded into the PC, and in the case of the SIMNET database for Fort Knox, it requires approximately 32 mega-bytes of memory. The Ft. Knox terrain database is composed of 15,000 terrain patches, with each patch representing a 500m x 500m square of land. Associated with each terrain patch is information about vertices, edges, terrain polygons, trees, tree lines, objects, canopies, and its coordinates. UPAS uses these coordinates to determine which patches to retrieve from the database for display on the PVD screen. Future work in this area involves adding contour lines to the PVD.

Tactical communications data still need to be integrated with the other data sources. Software will be developed for for integrating communications data with movement and firing event data in the exercise timeline. Future networked simulators will employ methods for digital transmission of radio messages over the simulation network , allowing tactical communications to be picked off the network and loaded into the relational database in the same manner as other network data packets. For SIMNET, software will need to be developed to allow observers to input data on monitored tactical communications into the relational database.

Speed

One of the most critical problems encountered was the large amount of time required to apply the PVD and Battle Snapshot to unit performance assessment. Effective use of these aids requires moving forward or backward quickly from one point in the battle to another. The prototype aids moved only forward in time, and many minutes were expended in moving from one point in the battle to another. The slow movement was due to the fact that these aids work by reading sequentially the series of numbered data packets to locate the time of interest to the user. For example, in moving from 1000 hours to 1015 hours, the program looks at the time stamp for each intervening data packet until it finds a packet displaying 1015. This problem was addressed by implementing a utility that creates an index file containing packet addresses whose time stamps are one minute apart from each other. When the user selects a new time to move to, the program uses the time to retrieve the appropriate packet address from this index file, and then it uses the packet address to retrieve the appropriate packet from the raw data file. In this way, only two disk accesses are used to find the desired point in the battle.

After integrating the terrain database with the PVD, a new problem was encountered regarding the time required to access a display. A substantial amount of time was required to generate the terrain display for the initial Plan View screen. This screen covered a 16 by 8 kilometer segment of the battlefield containing information from 512 terrain database patches. This problem was addressed by reducing the display to an 8 by 4 kilometer area covering only 128 patches.

Flexibility

Another important problem addressed was that of creating a system that could be adapted by the user. This flexibility was achieved, in part, by incorporating display options. For example, the UPAS user has the option of selecting the frequency with which the locations of vehicles are displayed in the Battle Flow Chart. The time dimension has been annotated on the flow path of each vehicle by placing position update markers on the path which are spaced at an interval selected by the user. This feature allows the user to choose a larger position update interval for a larger (or longer) exercise to avoid over-cluttering the path with too many markers.

Future work in this area is directed towards two subgoals. The first subgoal is to define the requirements for modifying the AAR aids to support performance assessment above platoon level. The second subgoal is to decide if there is a need to make the UPAS graph and table editors more flexible. The present graph editor is limited to producing graphs that display information as a function of time and counting variables only, and the present table editor will not support the preparation of tables that involve more than one Structured Query Language (SQL) query.

CATEGORIES OF PERFORMANCE MEASURES APPROPRIATE TO EACH TYPE OF AAR AID

Table 1 indicates the categories of measures assigned to each type of AAR aid. Categories involving communication require utilities for displaying tactical communications in the Exercise Timeline before they can be fully supported.

TABLE 1. CATEGORIES OF STANDARDS APPROPRIATE TO EACH TYPE OF AAR AID

CATEGORY OF STANDARD	AAR AID FORMAT				
	SCORECARD	FLOW CHART	SNAPSHOT	PVD	TIME-LINE
MOVEMENT AND FIRING				x	x
FRIENDLY AND ENEMY FIRES	x			x	
MOVEMENT AND CONTROL MEASURES		x	x	x	x
MOVEMENT TECHNIQUE AND METT-T		x	x	x	
MOVEMENT AND COVER/CONCEALMENT		x	x	x	
WEAPON ORIENTATION			x	x	
HALTS AND COVER/ CONCEALMENT		x	x	x	x
LOCATIONS OF FRIENDLY IDF MISSIONS AND ENEMY POSITIONS	x				
SPATIAL RELATIONSHIPS AMONG MOVING VEHICLES		x	x	x	
RATE OF MOVEMENT				x	x
LOCATION, CONTROL MEASURES AND COMMUNICATIONS					x
FIRING EVENTS AND COMMUNICATIONS					x

RELEVANCE OF UPAS TO OTHER APPLICATIONS OF DISTRIBUTED INTERACTIVE SIMULATION

UPAS has the potential to serve as a research tool in developing feedback systems for a variety of DIS applications. The Army's future fielding of networked simulators will comply with standards for interoperability of defense simulations, beginning with the Close Combat Tactical Trainer (CCTT). These standards include specification of the content and format of data broadcast over the network. The UPAS is designed to support current SIMNET protocols that differ from those in the interoperability standards. However, the functional requirements for the CCTT require interoperability with SIMNET, necessitating the development of a translator between the standard protocol and the SIMNET protocol. This translator will make it possible for the UPAS to address data packets from future DIS applications as well as supporting the current SIMNET.

The training research conducted on SIMNET using UPAS should also provide useful information for the development of other DIS applications. This information may include techniques for organizing, analyzing, and summarizing performance data, and it may include information relevant to the development of DIS training strategies.

SUMMARY AND DISCUSSION

UPAS is designed to support the inter-related goals of providing feedback to units and testing the effectiveness of SIMNET under various training strategy options. We have placed special emphasis on AAR aids that can be used to provide units with feedback promptly after an exercise. Future efforts will be concerned more with implementing performance measures that may require too much time to apply to fit into the short suspense framework of the AAR.

The UPAS is designed to be flexible enough to allow trainers and other system users to modify feedback displays to accommodate new information needs as they are discovered. This flexibility makes the UPAS an efficient tool for research on how to provide feedback.

The next step in UPAS development is testing the effectiveness of UPAS AAR aids as training feedback and research tools. The majority of this work will be completed at the Fort Knox, Kentucky SIMNET-Training Facility.

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